Inconsistent quality under global warming dampens strawberry performance in SEQ

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- Weather affects the yield and quality of strawberry plants
- Cultivars with stable fruit quality are preferred over those with variable quality
- Fruit quality data from six strawberry cultivars was collected to assess the stability of three key fruit quality traits (fruit weight, sweetness, and acidity) over a season
- None of the cultivars tested had high and stable fruit quality values suggesting more needs to be done to develop better performing cultivars, particularly for production under global warming

Introduction

Environmental conditions affect the yield and quality of fruit produced by strawberry plants. Fruit weight, soluble solids content (a measure of sweetness), titratable acidity (a measure of fruit tartness) and firmness increase with increasing solar radiation. These same parameters, however, decrease with rising, warmer temperatures, leading to reduced marketable yield and softer, blander tasting fruit.

In many agricultural crops, stable yield and product quality is as important as a high average yield or high product quality. This is also true for strawberries, where cultivars with stable quality under variable environmental conditions are preferred over those with variable quality.

In this research, the stability of yield and fruit quality parameters of six strawberry cultivars was assessed at trials in Nambour, Queensland. Bare-rooted transplants from Toolangi in Victoria were planted on 20 April 2022, and mature fruit were harvested weekly from 3 August to 19 October. Data on marketable yield, fruit weight, soluble solids content (SSC), and titratable acidity (TA) was collected and assessed for stability each week.

How stability was assessed

In this trial, the stability of yield and quality parameters for each strawberry cultivar was assessed using a regression protocol described by Finlay and Wilkinson (1963).

Cultivars with a slope from the averaged regression line of one (1) have average stability within the group.

Cultivars with a slope of more than one (1) are less stable than average, while cultivars with a slope of less than one (1) are more stable than average.

Results of the trial

Marketable yield was similar across the cultivars, ranging from 352 to 416 g/plant. Fruit size was smaller in *Festival* and *Grenada*, intermediate in *Fortuna* and the Advanced Selection, and larger in *Fronteras* and *Petaluma*. Average SSC was lower in *Fronteras*, *Grenada*, and *Petaluma* than in the other cultivars, while average TA was lower in *Fortuna* and *Fronteras* (Table 1).

All cultivars had similar estimates of stability for fruit weight (0.74 to 1.27), where a cultivar with a value of one (1) has average stability in a group. Estimates of stability for SSC and TA varied with the cultivar. Estimates of stability for SSC were lower than one for *Festival* and *Fortuna* (more stable than average), about one for the Advanced Selection and *Petaluma* (average stability), and higher than one for *Fronteras* and *Grenada* (less stable than average). Estimates of stability for TA were lower than one for *Fortuna* and *Fronteras* (more stable than average) and about one for the other cultivars (average stability) (Table 2).

There was a strong negative linear relationship between fruit weight and the temperature in the seven weeks before the fruit were harvested (P = 0.018, R2 = 0.39). Fruit weight decreased from 27 g to 22 g as the average daily mean temperature increased from 15.4° to 18.8°C. There was also a strong negative linear relationship between SSC and temperature in the eight days before the fruit were harvested (P < 0.001, R2 = 0.87). Soluble solids content decreased from 8.1 to 6.7% as the temperature increased from 15.1° to 19.8°C (Figure 1).

Table 1. Variations in marketable yield, and mean seasonal average fruit weight, SSC, and TA. Data are the means of six replicates per cultivar and were collected from 3 August to 19 October.

Cultivar	Marketable yield* (g/plant)	Fruit weight	Polytunnels Soluble solids content (%)	Titratable acidity (%)
Festival	379	21.3	8.3	0.66
Fortuna	363	25.0	7.5	0.58
Advanced Selection	352	24.7	7.4	0.67
Fronteras	416	27.6	7.1	0.55
Grenada	362	23.7	6.9	0.69
Petaluma	353	27.8	7.2	0.63

* Marketable fruits were at least 12 g fresh weight, were not affected by rain or grey mould, were not misshapen and had no other defects.

Table 2. Variations in the stability of fruit weight, fruit soluble solids content and fruit titratable acidity. Data are the means of six replicates per cultivar and were collected from 3 August to 19 October. Estimates of stability were calculated using the regression analysis used by Finlay and Wilkinson (1963).

Cultivar	Stability index		
	Fruit weight (g)	Soluble solids content (%)	Titratable acidity (%)
Festival	0.84	0.53	1.16
Fortuna	0.74	0.45	0.33
Advanced Selection	0.80	0.84	1.33
Fronteras	1.10	1.69	0.60
Grenada	1.19	1.75	1.29
Petaluma	1.27	0.88	1.11

Significantly more stable than average **Average stability** **Significantly less stable than average**

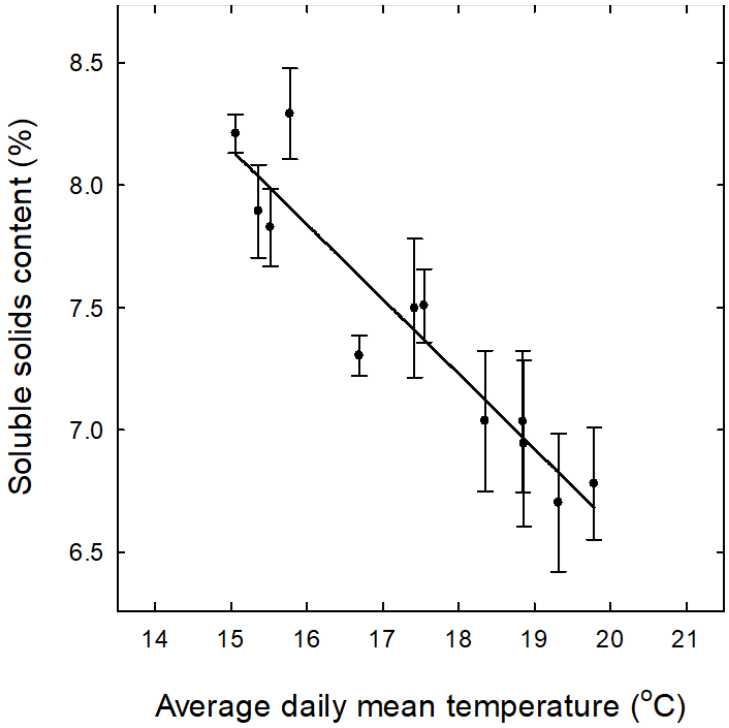

Figure 1. Relationship between average fruit SSC and average daily mean temperature. Temperature data was averaged over the eight days before harvest. Data points are the averages of six cultivars (± standard error). SSC = Intercept – 0.31 × Temperature ($P < 0.001$, $R^2 = 0.87$, n = 12).

Fruit quality varied with the cultivar and harvest and there were differences in the stability of fruit weight, SSC and TA. These differences in quality would affect the marketability of the various cultivars.

Hasing et al. (2013) studied the changes in SSC over the season in Florida. The typical harvest in this area extends from November to March and is characterised by a range in the weather. Hasing and colleagues found that SSC ranged from 5.1 to 9.9% in the first season and from 6.5 to 10.6% in the second. Approximately 90% of the genotypes had average stability, with the remaining 10% equally distributed between unstable and stable groups. There were a few genotypes with a high average SSC and stable values over the season.

The flavour of strawberry is a complex mixture of various attributes, including sweetness, acidity and aroma. Guan et al. (2022) indicated that First Grade fruit in the United States must have a SSC of at least 7%.

In the present study, the different cultivars varied in the number of occasions they failed to meet this standard. *Festival* and *Fortuna* passed on all harvests, Advanced Selection and *Petaluma* passed on eight or nine harvests, while the other two cultivars passed on six or seven harvests.

The quality of the strawberries varied with the cultivar and the time of harvest in the trials. *Festival* and *Grenada* had smaller fruit than the other cultivars. *Fronteras*, *Grenada* and *Petaluma* had lower SSC and *Fortuna* and *Fronteras* had lower TA. Both fruit weight and SCC decreased with increasing temperatures. None of the cultivars had high and stable values for all three fruit traits.

Inconsistent fruit quality dampens the performance of strawberries in southern Queensland. Efforts need to be made to develop cultivars with high average and stable quality values suitable for production under global warming. Research is also required to determine the stability of fruit quality in other growing areas.

Acknowledgements

The Queensland government is funding the research through the Department of Agriculture and Fisheries. Many thanks to the Florida Strawberry Growers' Association (FSGA) for financial support and to Gary Hopewell for reading an earlier draft of the article.

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